

PennDOT'S ROAD TEST of the ROAD SAFETY AUDIT PROCESS

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FORWARD

This report details my experiences as Coordinator of the Road Safety Audit Process Pilot in Engineering District 10 of the Pennsylvania Department of Transportation (PennDOT), and may assist those responsible for the maintenance of public roadways determine if and how the process should be considered for use.

PennDOT began a pilot process in April 1997, which ended in December 1998, to determine if and how the Road Safety Audit Process should be incorporated into designs of roadway construction projects in Pennsylvania. The goal of the pilot was to determine if the Road Safety Audit Process adds value, if it can be incorporated utilizing existing resources, and if it will delay project delivery. Two of PennDOT's eleven Engineering Districts utilized research compiled by the Pennsylvania Transportation Institute of the Pennsylvania State University, under a contract from PennDOT, to become familiar with the Road Safety Audit Process. The Districts separately adapted the process to suit the structure of their organization and began implementation. The Pennsylvania Transportation Institute monitored the results to help achieve the goal.

In District 10, preplanning was performed to ensure that the Pilot would provide valuable information. The framework of the audit process for the Pilot comprised of selecting team(s) members, selecting projects, conducting audits, documenting and communicating results, and incorporating improvements. Because variations in any of these affect results, various approaches were used as the audits were conducted. Details of experiences, i.e., results, effects, benefits, costs, and challenges/opportunities were continually observed and used to form recommendations to help with statewide implementation. The costs incurred, the benefits gained, the opportunities afforded, and the noteworthy observations made during the audits were continually evaluated with close monitoring of the following issues:

- Team make-up
- Employee time
- Project cost
- Project delay
- Documentation
- Suitable types of projects
- Suitable phases of project development
- Control of projects
- Conflict resolution
- Liability

Recommendations have also been developed using the experiences of the year and one half long Pilot Project. Soon after implementation, it became obvious that Road Safety Audits added value in the form of real safety benefits to road users. A detailed evaluation was completed to determine how to effectively adapt the process for use.

KEY ELEMENTS

It may be very easy for an agency to initially assume that they have no need for a Road Safety Audit Process or that they already are performing this process. To fully appreciate the value and uniqueness of the Road Safety Audit Process, one must understand its key elements as it has been utilized in other countries, such as Australia, New Zealand, and Canada.

- The needs of all road users, not just automobiles, are considered in the Road Safety Audit Process. Emphasis is given to pedestrians, bicyclists, large trucks, buses, emergency vehicles, and railroads.
- The Road Safety Audit Process has access to the design continually through project development. The ideal Road Safety Audit consists of five separate and formal reviews: one review during the feasibility, preliminary design, final design, pre-opening (construction), and in-service phases. This allows safety to be a more integral part of the design of the transportation facility.
- Field views focused purely on safety issues are conducted as part of the formal reviews. A team of experts brainstorm safety concerns and recommendations during the field view. Solutions are not required.
- The Road Safety Audit Team attempts to anticipate crashes. This is a proactive approach. In fact, crash history is not normally used. An agency additionally needs to ensure that crash history and the other needed elements are integrated, with the Road Safety Audit remaining a separate process.
- The Road Safety Audit Team generates a formal report after each audit; the Project Manager formally responds by stating actions taken or why actions were not taken.

There is no ideal adaptation of the Road Safety Audit Process. It is recommended that after the process is well understood, the agency should then determine how to best implement the process utilizing the strengths of their organization.

PROCEDURE

The Road Safety Audit Process is not a radical change in project development; however, it is a change. Since change is not always well accepted, the audits were not forced into project development where they could potentially create chaos by demanding actions that could disrupt project development. Instead, citing of potential problems were made in such a manner so as to test its limits. Ground rules were developed to allow unbiased information to be gained so the Pilot would provide a true representation of what can be expected if the process is implemented and allow for better recommendations of how it should be adapted.

The ground rules were as follows:

- 1.) The Team must reach consensus on citing concerns,
- 2.) The Coordinator must avoid hidden agendas, and
- 3.) The Team must accept the decisions of the Project Manager.

PennDOT's pilot initially adapted a procedure that followed closely with that of Australia. The generally accepted procedure is as follows:

Program Development...

- ✓ ***Achieve management commitment, or “buy-in”.*** This commitment is extremely important and can allow the process to succeed by providing opportunities when time and money may be jeopardized. There must be willingness to redesign, investigate new ideas, move outside the scope of work, and most importantly, to adjust the agency's overall program to find funds.

- ✓ ***Carefully select audit team(s).*** Experienced team members in the various facets of highway engineering is the most important key element of the Road Safety Audit. Additional members with experience in key areas should be added as needed on a project by project basis. Additional key members may even assist at different phases in project development, e.g., a geometric design expert in the preliminary design phase or a work zone traffic control expert in the pre-opening phase.

- ✓ ***Select the projects to be audited.*** The Road Safety Audit Process may not be suitable for all types of projects and the number of projects to audit will depend on the availability of human resources. Experience with the process will help with this determination.

Beginning the Audits...

- ✓ ***Review all of the available background information.*** The Team should obtain a good understanding of the project's plans, scope, purpose, history and constraints.

- ✓ ***Conduct field reviews at specific stages throughout project development using detailed checklists.*** The detailed checklists are reviewed and completed to stimulate thought and ensure that all safety concerns are considered. The Team must reach consensus of items that will be identified so recommendations creating conflict can be identified as an audit need, and not self-serving. Everything that the experts know, have learned, or can deduce is used to brainstorm safety concerns. Practical application of policies, standards, stakeholder needs, and most important, experience, drives the audits.

- ✓ ***Draft a formal report of findings.*** A formal report that is clear, concise, and contains the safety concerns and recommendations that surfaced from the audit should be drafted in a timely manner.

- ✓ ***Conduct a completion meeting.*** A meeting with the Coordinator and the project manager is held to resolve concerns, discuss details not included in the report, and discuss remedial treatments.

- ✓ ***Resolve conflicts between those responsible for the design and the audit.*** Conflicting views of potential problems and/or needed countermeasures may arise and need resolved. This is when management commitment and a good understanding of the Road Safety Audit Process will assist.

✓ ***Incorporate solutions into the design.*** All of the previous are instrumental in allowing the most important step of incorporating solutions into design to occur. Since the Road Safety Audit Team reviews a project up to five times during project development, the Team can continually monitor progress and, not only ensure incorporation into the project, but also allow for integration of successful improvements into similar projects under design.

✓ ***The entire procedure can be repeated when the project enters into the next phase of project development.*** Experience with the process will help determine the number of audits to perform throughout a project's development. Not all projects need an audit in all five stages. Factors will include the type of project, when the initial audit was conducted, the level of detail reviewed previously, the time lapse from the previous audit, the level of team-expertise previously utilized, and the value added by the previous audit. A continual review process will monitor previous issues and any changes made since the previous audit.

Various approaches in all aspects of the framework [i.e., team(s) members, selecting projects, conducting audits, documenting and communicating results, and incorporating improvements] of the pilot process were tried to determine cause and effects. The process was continually modified as the various approaches were evaluated.

SAFETY REVIEW vs. SAFETY AUDIT

Any United States agency using federal monies must perform a safety review of the project at the end of the preliminary engineering phase and final design phase of project development. These are not Road Safety Audits. Both have their unique purpose and their differences are helpful in understanding the potential value of the Road Safety Audit Process. The following identifies the differences in the generally accepted **Safety Review** Process and the **Safety Audit** Process:

Safety Review utilizes a small team with design expertise.

✓ Safety Audit utilizes a larger team with interdisciplinary expertise.

Safety Review Teams are usually involved in the design or a similar design.

✓ Safety Audit Teams are totally removed and totally unbiased.

Safety Review Teams normally do not perform a field review.

✓ Safety Audit Teams will perform 1 to 5 field reviews on a single project. Many concerns can only be discerned during a field review.

Safety Review Teams review plans to ensure that all design features are in compliance with Standards.

✓ Safety Audit Teams utilize a comprehensive Checklist that covers many design features not normally considered during the design of most projects.

Safety Reviews normally do not consider Human Factors. Most crashes occur because of driver error.

✓ Safety Audit focuses on drivers' reaction to certain highway features, including improvements, and discerns problems and concerns not normally considered.

Safety Review Teams normally do not consider the needs of other modes of transportation.

- ✓ Safety Audit Teams consider multi-modal safety concerns, including that of pedestrians, bicycles, large trucks, motorcycles, railroads, buses, etc.

Safety Reviews normally ensure that crash clusters and remedial improvements are considered. This is a reactive approach to existing concerns.

- ✓ Safety Audits normally do not consider crash history, but anticipate crashes. This is a proactive approach to incorporating safety into roadway projects.

Incorporating the Road Safety Audit Process into the Safety Review Process is an issue that was often suggested so not to add additional steps into project development. Roadblocks to this can include the following:

- **Timing** - Early input is vital, continual input is desirable. Normally, Safety Reviews are not conducted until near the end of the preliminary design phase and again at the end of the final design phase of project development. This may not be early enough in project development and may restrict incorporation of some improvements.
- **Time consuming reviews** - Safety Reviews are conducted on almost all projects. Auditing all projects may not be feasible considering existing human resources. Downsizing the audit procedure may be needed without adversely affecting the effectiveness of the Road Safety Audit's key elements.
- **Acquiring multi-modal input** - Safety Reviews do not normally consider multi-modal needs.
- **Resisting project development constraints** - This may be challenging since time and money concerns are always major issues.
- **Incorporating additional safety enhancements** – Normally, Safety Reviews evaluate existing features for compliance with standards and do not consider new or different approaches, which could be difficult to incorporate due to time and money constraints. Also, they do not normally include field views, which provide valuable input toward attempts to maximize opportunities to enhance safety and minimize missed opportunities to enhance safety.
- **Considering human factors** - This is challenging due to a lack of past emphasis and expertise, but may be able to be somewhat addressed through the use of checklists.

DISTRICT PROFILE

Located in western Pennsylvania, Engineering District 10 is comprised of five counties: Armstrong, Butler, Clarion, Indiana, and Jefferson. The District covers an area of 3,569 square miles with a population of approximately 400,000. There are 3,201 road miles under the District's jurisdiction of which 283 are on the National Highway System. Most of the road miles are rural in nature. The Engineering District Office has 243 employees and has over 225 projects under design.

ROAD SAFETY AUDIT PILOT PROCEDURE

The following will provide a summary of the procedure that District 10 used in the Road Safety Audit Pilot:

Selection of Teams

A Safety Audit Team of five members was used. The Team members consisted of the following representatives:

- ◆ Traffic Engineer
- ◆ Construction Services Engineer
- ◆ Design Project Manager
- ◆ Maintenance Program Engineer
- ◆ Risk Management Engineer
- ◆ Comprehensive Safety Coordinator

All of the members were PennDOT District 10 employees, except for the Comprehensive Safety Coordinator, who is employed by the Indiana University of Pennsylvania and is available to assist the Department in a community relation and educational capacity. The District's Pilot utilized a Road Safety Audit Coordinator to direct the audits and document results. The District Traffic Engineer was selected as Coordinator and to provide expertise in signs, signals, markings, and safety. The Construction Services Engineer had expertise in design, traffic engineering, and construction. He is also a member of the District's Administrative Staff and the Program Management Committee. The Design Project Manager provided expertise in highway design standards, accident reconstruction, and traffic engineering. The Maintenance Program Engineer has experience in maintenance and traffic engineering. The Risk Management Engineer provided expertise in tort liability, traffic engineering, and environmental impact requirements. The Comprehensive Safety Coordinator was chosen to provide expertise in the areas of human factors and highway safety education. A preliminary meeting was held to familiarize team members with the Road Safety Audit Process.

The same team was used to review all of the projects in the Pilot. Other employees having key expertise were utilized periodically as additional resource people (e.g., bicycle/pedestrian needs in the feasibility and preliminary design phases and work zone traffic control specialization in the pre-opening phase.)

Selection of Projects

The projects that were part of the Pilot were selected by the Road Safety Audit Coordinator and the Assistant District Engineer for Design. The primary consideration in the selection of the projects was to have a variety of project types currently in various phases of project development. This was done so that the effect of the audit process could be evaluated for several different types of projects. Eleven projects were chosen. This group of projects ensured that at least one project would match up with each of the different audit stages.

The eleven projects selected are as follows:

- ❑ U.S. 422, Armstrong County (Kittanning Bypass) – preliminary engineering phase of a Capital Project covering five miles of new construction of a four lane concrete roadway
- ❑ U.S. 119, Indiana County – preliminary engineering phase of a Capital Project covering 10 miles of a two lane roadway being reconstructed into four/five lanes with a median barrier, left turn lanes, and jughandles
- ❑ U.S. 119, Jefferson County (Jenk's Intersection) – preliminary engineering phase of a SAMI (Safety and Mobility Initiative) project covering the reconstruction of an intersection to provide a left turn lane and improve intersection geometry
- ❑ PA 66, Armstrong County (Forks Church 3R) – final design of a Betterment Project covering the redesign of six miles of rural two lane roadway with narrow shoulders and poor alignment
- ❑ U.S. 119, Jefferson County (Punxy South Climbing Lane) – feasibility stage of a Capital Project covering three miles of two lane reconstruction to provide a southbound truck climbing lane
- ❑ PA 56, Armstrong County (South Bend Bridge) – preliminary design of a 200 foot long Bridge Replacement Project that included reconstruction and improvement of the roadway's horizontal and vertical alignment
- ❑ U.S. 119, Indiana County (Marchand 3R) – final design of a Betterment Project covering three miles of rural two lane with poor horizontal and vertical alignment
- ❑ State Route 4023, Armstrong County (Tarrtown Road) – preliminary design of a Capital Project covering three miles of rural road with poor alignment and cross section, heavily traveled by large trucks
- ❑ U.S. 119, Indiana County (Little Mahoning 3R) – pre-opening phase of a Betterment Project covering three miles of rural road with project tasks including the realignment of several curves
- ❑ Butler County Surface Improvement Project – final design phase of a project that consists only of resurfacing various roadways throughout Butler County
- ❑ U.S. 22, Indiana/Cambria Counties (Gas Center) – preliminary engineering of a Capital Project covering eight miles of new four lane construction, mostly on existing alignment, including several jughandles

Overview of Audit Procedure

A full day work session was scheduled to complete each project audit. The Road Safety Audit Coordinator began by giving a brief refreshing on the Road Safety Audit Process. The Project Manager then provided information on the proposed scope of work and background issues of the project. If a consultant was used for the design, this briefing was given with a representative from the consultant's design team present. After the briefing, the Road Safety Audit Team reviewed the project plans and briefly discussed possible safety and multi-modal concerns with and without the Project Manager present. Once this review was completed, the Team field viewed the site. The field views were videotaped throughout the entire review to capture both audio of the Team's discussions and video of the roadway's features. The Team then returned to the office to discuss the issues that were identified from the field view. The outcome of these discussions was used for the development of a preliminary set of concerns and recommendations from the Team. After the meeting, the Coordinator met with the Project Manager to determine if the recommendations were feasible, given the project's

current status, and determine what countermeasures/improvements may alleviate the cited concerns. The Coordinator developed a short (one or two page) letter to the Assistant District Engineer for Design outlining the recommendations and concerns from the audit. Continual discussions with the Coordinator and Project Manager took place until a remedial treatment was incorporated into the project or an alternative means to mitigate the concern was agreed upon. The Project Manager was asked to respond to the Coordinator's letter. The Coordinator monitored the project to determine if and when the next audit should take place. Due to the limited timeframe of the pilot process and the need to try various methods of conducting the audits, little emphasis was placed on re-auditing any one project. Focus was more on conducting as many audits using as many different methods as possible.

Conduct of Field Views

The field views were conducted by having the Audit Team travel to the project site in a van. The Team drove the project limits in both directions. The Team also drove beyond the project boundaries to note features along adjacent sections and/or routes. Each run was videotaped to provide a visual record and to record spoken comments from members of the Team. No effort was made to reach a consensus on any issues noted during the field view. Rather, as issues were raised, they were noted with the idea that they would be discussed in detail once the Team returned to the office. The field view was used as a brainstorming session. The videotape was often used to revisit issues during the deliberation session at the office.

Development and Communication of Recommendations

The Team developed a preliminary set of recommendations based on their plan and field reviews. Once these preliminary recommendations were developed, the Coordinator investigated the feasibility of correcting the concerns relative to the project's status. The Coordinator developed a final set of recommendations regarding the project. These final recommendations were first discussed with the Project Manager and then were sent in the form of an interoffice letter to the Assistant District Engineer for Design. A copy of this letter was also provided to the members of the Team. The Project Manager was asked to respond to the letter with intended actions. As experience with the process progressed, only concerns were cited with no firm recommendations. A meeting was held after the audit with the Coordinator and the Project Manager to discuss the concerns and possible improvements for remedial treatments.

BENEFITS

District 10 formed a quick appreciation that the Road Safety Audit Process adds value in the form of safety benefits to road users. The following is a compilation of the benefits realized throughout the Road Safety Audit Pilot:

- ❑ It helped to ensure that changes to the roadway by the designs will not compromise safety through the scrutiny of the roadways' crash potential and the projects' scope of work.
- ❑ The audits forced Project Managers to react to safety concerns early in project development before non-safety related constraints, such as time and money, were in control of the project.
- ❑ The audits provided input with concerns of road users not normally considered in the design of most projects. These concerns became part of the scope of work, and not an afterthought when it may be too late to provide a remedial improvement
- ❑ Approximately 50% of the cited concerns resulted in improvements beyond the existing scope of work. Although no improvement has yet been constructed and experienced traffic to determine if the improvements were beneficial, most were based on sound engineering principles and previous successes, so they should assuredly provide a higher level of safety.
- ❑ Inherently incorporates *"Quality through Prevention"* which is a core value of the Malcolm Baldrige Quality Assessment by ensuring that quality is maintained by preventing some common occurrences: 1.) Undesirable effects of motorists which can create potential safety concerns and costly changes in the future. 2.) Certain standards or combination of standards may be inappropriate or unnecessary and can create potential safety concerns or detract from a more viable improvement, and 3.) Changes to design features made during value engineering reviews and/or construction may create safety concerns. A timely audit can ensure these occurrences are not unwary, unnoticed, or unchallenged. For example, drainage features are often compromised due to the high costs that can be saved. Drainage is one of the most important safety items in a construction project and it can also be the most expensive to correct after the fact. A timely Road Safety Audit can help minimize these occurrences. An improvement may cost a lot; but it will cost much more if you must retrofit later. It may be an inferior product, also.
- ❑ Opportunities to enhance safety were maximized and missed opportunities to enhance safety were minimized by attempting to take advantage of the project to make needed safety improvements. Additionally, several occurrences of missed opportunities to enhance safety on recently constructed projects would be raised had those projects been audited.
- ❑ Experienced gained on a project, even through a "non-success", was translated to other projects. Successful incorporation of improvements into projects prompted the Coordinator to then look for, and separately integrate, these similarly into the development of other projects not having a formal audit.

- ❑ Interdisciplinary input was valuable in citing safety concerns outside those normally cited by the present Safety Review Process. Representatives without a strong safety background raised many concerns. Through brainstorming and achieving consensus among a team of multi-disciplinary experts on many safety-related concerns, the Pilot Team Members also gained individual knowledge of the other disciplines. Information gained at every audit could be applied to other audits and day-to-day duties. The Pilot Team also had the opportunity to perform an audit with representatives of the Federal Highway Administration who provided valuable geometric design expertise that was obtained through experience with other State Agencies.
- ❑ Discerned concerns through site reviews and observing the roadway's operation. Field views occur throughout normal project development, but none focus purely on safety for all road users and allow for citing of concerns without regard of how the concerns will be corrected.
- ❑ Experienced Team members during field reviews found ways to build things cheaper. It was not uncommon for "value engineering" and "constructability" to be discussed during the field views with cost saving suggestions resulting.
- ❑ The process forced communication to occur throughout the disciplines and better informed the various work units of actions and intentions.
- ❑ Having access to the design throughout the development of a project better-enabled safety concerns to be cited by having a better understanding of the project and, simply, having more chances to scrutinize design features.
- ❑ Having access to the design throughout the development of a project better ensured that safety concerns did not get lost, removed, or changed throughout the project development.
- ❑ The process helped ensure the safest design for all road users. Often, standards only provide the minimum treatment required. This is often not enough, especially when considering a facility that should be safe and compatible for trucks, emergency vehicles, and bicycles.
- ❑ Consistency was created in many areas because the formal report was circulated throughout the agency and educated others responsible for similar designs. It also created consistency by ensuring appropriate standards are being used and by considering adjacent networks. For example, the design of jughandles was modified due to the crash experience noted in another PennDOT District.
- ❑ The Project Managers experienced a higher level of comfort through knowing that their project(s) have been scrutinized by others. They were more assured that their design will produce the highest quality construction project possible and will serve all road users. The Road Safety Audit Team was also called upon for review of specific features with which a project manager was struggling. This served to assist the project manager and to encourage and build confidence in the Road Safety Audit Team. However, care was taken not to use the process "as a crutch."

TYPICAL IMPROVEMENTS

A variety of improvement types resulted from the audits. Intersection improvements were the most drastic changes to the scope of work. These included basic improvements, such as a removal of earth banks to improve the available corner sight distance and an addition of left turn lanes to reduce the number of stopped vehicles on the roadway. These also included more complicated improvements; such as a realignment of the approaches to improve the vehicular movement conflicts and a redesign of an interchange to eliminate left turn movements and create driver-friendly and safer right turn movements. Major effort was given toward consideration of replacing an at-grade, signalized intersection with an interchange. The improvement ultimately was not incorporated into the construction project because of environmental and money constraints; however, the District is considering a separate future project.

The presence of fixed objects is a very common concern that arose from the audits. Focus was often on removing, relocating, and/or combining above ground utilities that posed as potential fixed object hazards, particularly where there may be an undesirable increase in vehicular speeds. This potential is best determined through field reviews focused purely on safety.

Access Management improvements, such as relocating, removing, and/or eliminating driveways were successfully incorporated into the design of projects. Since these improvements tend to be unfavorable for the affected property owners, these types of improvements were successfully incorporated when addressed early, but not without a considerable amount of effort from the Project Managers.

Two projects successfully incorporated a paved and protected area to the side of the roadway that will be utilized for weight, inspection, and speed enforcement to control adverse driver behaviors.

Jughandles were modified to include highway lighting, to be more uniform with others on adjacent roadways, and to better accommodate trucks. Also, the Road Safety Audit Team made the District consider the use of a wider median instead of median barrier through a location so as to not utilize jughandles or restrict pedestrian travel.

COSTS

It is estimated that the average cost of an Audit in the pilot process was \$2,000 to \$5,000. This cost includes only salary and equipment costs from the Team using only Department employees. (Naturally, added improvements have added costs to the project development; however, this is not considered as a cost of the audit.) This is very little for the amount of success achieved. Most of the time and efforts were placed on a select few projects. Not all projects necessitated the same level of effort to conduct the audit. Given rough estimates that were made and based on a simple \$50/hour analysis, conducting an audit added between \$2,000 and \$3,000 per review, per project in salary and equipment, when conducted internally. These costs are comparable with estimates produced in the United Kingdom, Canada, and Australia. Audits conducted by an external Team, such as a consultant or another agency, were not used. However, projects utilizing consultant-engineering designs created a slightly higher audit cost of \$4,000 to \$5,000.

The Pilot also had “intangible costs” that cannot have a price tag placed on them. They were not insurmountable and were minimized through awareness. They include the following:

- Any concern that was cited may raise an issue in a lawsuit that may not have been raised if it had not been cited by the agency, itself.
- Concerns that are not addressed may be considered a tort liability if it gets to the attention of a party in a future lawsuit.
- Delays and changes were inevitable and generated costs in the form of lost time available for other duties. One redesign created a loss of credibility with property owners when it also forced undesirable, additional right-of-way acquisitions. Property owners were told that their property would not be affected by the project and the audit created a change in the design and a need to acquire some of their property. This created distrust. Property owners do not appreciate nor understand that changes in design occur, let alone ones that affect them personally. Credibility is very important to an agency.
- Redesigns caused the timing of the projects’ milestones to become off-track. No different than any other change, the audits created many unplanned changes. However, after the pilot began, many Project Managers began to anticipate the possibility of changes. The key is to start early to minimize conflicts associated with letting dates, completion dates, and commitments.

CHALLENGES and OPPORTUNITIES

Because the Road Safety Audit Process is a new concept to PennDOT and to most of the United States, and because the process involves time, money, work, and change, problems were expected and problems occurred. Problems occurred in several of the methods used when varying the framework of the pilot. Problems also occurred in the form of failed attempts, or “non-successes”, to incorporate needed improvements. However, the pilot was structured to accept the problems and/or failures, learn from them, and use them as opportunities to improve the process and other projects. Some may reason that since not all of the cited concerns were accepted, senior management will not allow the process to control the delivery of roadway construction projects but will only allow it to work when convenient. This was not true. However, even if it were, so what! Many improvements resulted at a small cost along with opportunities to apply the experiences of the non-successes on other similar project where existing conditions may permit incorporation. This is not failure, but an opportunity to improve the overall roadway system. Well acclaimed scientist, Louis Pasteur is quoted as saying *“I learn more from my failures than from my successes.”* This quote is most appropriate when concerns that were raised did not result in incorporating improvements. The pilot accepted these non-successes and analyzed them to help provide information in determining how to best adapt the process.

The challenges and opportunities include the following:

- ❑ Numerous concerns were challenged because the audit was conducted late in project development after many decisions were made and the project advanced.
- ❑ The Road Safety Audit Process requires a considerable amount of the Coordinator's time. Since the Coordinator's time and benefits gained were found to be directly proportional, maintaining aggressiveness was difficult.
- ❑ High level managers participating on the team created successful audits; however, their busy schedules constantly changed, often by others and beyond their control. Organizing and postponing field reviews created frustration.
- ❑ Team members changing positions was also experienced. This required a new learning curve for the replacement member and caused a loss of experience for the Team.
- ❑ Usually no plans existed early in project development when it was best to begin an audit. This made a detailed review more difficult because some features and design decisions were not yet made and there was no foundation on which to begin. This also required the Coordinator to track numerous options, possibilities, and directions.
- ❑ It was found that there is a very short window of opportunity when change was, somewhat, easy. When the initial review was during a later phase, difficulties with design changes occurred and selling was difficult. Because of many futile experiences, the Pilot eliminated reviews during later phases when there had been no initial review early in the project development phase.

- ❑ Recommended changes that forced the scope of the design outside of the environmental footprint were challenged (and not incorporated) because time needed to reevaluate environmental impacts may have delayed or even jeopardized the project.
- ❑ The Safety Audit Team received some of the same pressures from the constraints often experienced in normal project development, such as money and time.
- ❑ Decisions to incorporate improvements were, at times, controversial and required many meetings, discussions, and changes. This required time and cost money, especially when consultant design was utilized.
- ❑ The Coordinator spent a lot of time determining the best way to state concerns due to fear of tort liability. The Project Managers had even a more difficult time trying to draft responses to the formal reports. It was difficult to determine when the completed formal response should be drafted. This is due to the dynamic process that does not occur synchronously for the various concerns. Some are resolved quickly, and some slowly. There is no convenient time to respond and be assured that addenda will not be needed and tort liability will not be created. Several issues were not accepted due to environmental issues but were later resolved after the response was drafted.
- ❑ Unnecessary work occurred through a lack of timely communication. A project had a major down scoping occur for fiscal reasons. Because the Coordinator was unaware of this change, an unnecessary and futile field review occurred. In another project, the Coordinator also performed research unnecessarily to sell a concern when the change was already accepted.
- ❑ Metric plans created frustration. (Pennsylvania is relatively new to metrication and is proceeding through a major learning curve.) Although most Designers and Project Managers are familiar with metric designs, many other disciplines are not, causing frustration and making it difficult and cumbersome to compare design standards to field conditions. Also, issues may have been inadvertently overlooked due to unfamiliarity. The Team was made up of “old dogs” that are trying to learn “new tricks.”
- ❑ Every project had unique road users and stakeholders. It was difficult to gain input from all concerned. Having a representative from all local municipal officials, emergency services, transit agencies, businesses, and interest groups on the Road Safety Audit Team is desirable but was unmanageable. (PennDOT occasionally utilizes Community Advisory Committees to gather concerns in selected projects; however, the enormous amount of time required for this made it impractical for all Road Safety Audits. Therefore, the Team acted in the interest of all road users through using their experience and discussing issues with appropriate non-agency members.)
- ❑ Too many people involved in an audit made reaching consensus challenging and, at times, stifled issues because consensus could not be reached.
- ❑ The Pilot was successful in only approximately 50% of attempts to improve particular situations. Mostly because late changes can be difficult to incorporate and still remain

on time and budget and, for evaluation purposes, the types and phases of projects that were audited were varied which disadvantaged many attempts from the start.

❑ Maintaining “Buy-In” throughout the Pilot was often challenging. Many issues scrutinized by the team were closely reviewed previously through the normal project development. This was occasionally looked upon as potentially destructive by considering going backwards in project development. This was minimized by limiting dialogue with those involved with the design to only necessary communication. Also, because many issues raised by the audits were also raised through the normal development, lengthy audits rose questions as to the “value added” by the audit process. This can be minimized through experience with the audit process by selecting projects and project phases more conducive to the audit process having less repetition of that in the agency’s routine project development. In addition, many representatives throughout the Design Section of the Engineering District Office were reluctant to accept another procedure within the busy and structured project development. However, those involved with the audits appreciate the benefit potential of a review focused purely on safety with a relatively limited investment of time. Gaining buy-in from the other Engineering Districts was extremely challenging. Sufficient briefing prior to discussing Statewide implementation among my counterparts was not performed and most were very reluctant to accept the Road Safety Audit Process upon the first discussion.

WHAT IS BUY-IN?

The Road Safety Audit Process is not a radical change in project development; however, it is a change. Since change is not always well accepted, it was very helpful that all involved understood, appreciated, and accepted the Road Safety Audit Process as a tool for enhancing the safety potential of the construction project.

The Pilot discovered that audits could be conducted more smoothly through a commitment to safety when the following issues are understood and remain acceptable by Senior Management:

- ❖ Willing to commit human resources necessary to conduct audits
- ❖ Willing to commit human resources necessary to redesign portions of the project
- ❖ Willing to commit funds necessary to incorporate improvements
- ❖ Willing to adjust programs to find funds necessary to incorporate improvements
- ❖ Willing to investigate new ideas
- ❖ Willing to move outside the scope of work

The Pilot discovered that audits could be conducted more smoothly if the following issues are understood and remain acceptable by the Road Safety Audit Team::

- ❖ Some time must be devoted
- ❖ Audits are not the ultimate authority, and are used as a tool to identify safety needs
- ❖ The District has multiple needs
- ❖ Wheels may spin
- ❖ Not all concerns can be feasibly corrected
- ❖ Gaining consensus helps support cause

OBSERVATIONS

The Road Safety Audit Pilot continually evaluated ten previously mentioned factors as various methods were used in the trial-and-error procedures so that successes and non-successes would help in determining the optimum adaptation. The following highlight the noteworthy observations:

TEAM MAKE-UP: The make up of the Road Safety Audit Team was an extremely important consideration in ensuring a successful audit. The Pilot selected District representatives having backgrounds that were identified in the prior research as the disciplines most needed for Road Safety Audits. The pilot team consisted of five members with strong backgrounds in safety, traffic engineering, risk management, accident reconstruction, design, construction, maintenance, and programming disciplines of highway engineering. All members had a variety of the needed expertise. Human factors expertise was not available within the District and the Pilot did not seek an expert. However, the Team included an individual from Indiana University of Pennsylvania who associates daily with the local schools and aging agencies. Police officers could have been utilized if accident reconstruction expertise was not available. However, the need for this expertise was not felt to be as instrumental as were the others. Their knowledge of the operational concerns of the roadway is very useful and having them as a resource person was helpful. Since the Road Safety Audit Process is to be independent of the routine safety reviews, the Pilot Team did not include the Safety Engineer. Successful audits were conducted without this expertise. Additionally, it is very beneficial that Road Safety Audits are conducted as an added level of safety that focus on less obvious and traditional design features.

Naturally, knowledge of safety is a must. Understanding the AASHTO Roadside Design Guide, positive guidance techniques, and how and why crashes occur were very valuable skills in determining potential problems. Knowledge of current standards assisted in quickly identifying to the team what the roadway features will look like. Geometric design expertise helped in relating the relative safety associated with the various design features

The entire Team must thoroughly understand the Road Safety Audit Process and accept the bad with the good. Not all concerns may be accepted. Understanding the process is necessary so the field reviews will remain productive and concerns raised remain reasonable and prudent. Having at least one high level manager assisted in maintaining credibility by adding well-rounded knowledge of the agency and, therefore, helped determine what may be feasible and what may not.

The Road Safety Audit Process needs a person that fully understands and embraces the process to be the Coordinator. When the Coordinator is inactive, so is the Team, and so are opportunities for improving safety. An aggressive Coordinator can greatly help in monitoring recommendations, auditing more projects, and staying in constant contact with Project Managers.

Separate Road Safety Audit Teams reduces the amount of time of the team members and allows specific expertise to be utilized for appropriate projects. Maintaining the same team throughout the process builds expertise, provides

consistency from project to project, reduces the possibility of making the same mistake twice, and reduces the possibility of missing the same opportunity to enhance safety twice.

The Pilot Team occasionally had additional members attend plan and field reviews to provide specific expertise. A large group made reaching consensus and maintaining focus very challenging.

Non-agency members may also provide valuable information; however, there is a risk of losing control of the project by potentially allowing unfavorable information outside of the agency. It may be better to search for the needed information offered by others through other formats. An agency may not have all of the recommended expertise; therefore, training may be necessary. Training in the needs of pedestrian and bicyclists was provided to several members.

As team members change, so will the training needs. In time, expertise will build. The Team also must buy-in to the Road Safety Audit Process by understanding the process and their role.

EMPLOYEE TIME: The Team met when reviews were scheduled. This was approximately one day per month. The Project Managers that had a project subjected to a Road Safety Audit needed time for preparing briefings, attending field views, searching for solutions to concerns, redesigning features, contacting property owners, resubmitting for required approvals, communicating with the Coordinator, and seeking necessary funding increases. This was approximately three days per month. The Coordinator needed time for arranging meetings and field reviews, analyzing field notes, processing reports, communicating with designers, and researching possible solutions to concerns. This consumed approximately five days per month for ten separate audits.

Time and effort are directly proportional to the value added and quality of an audit. That is, the more time and attention to details given to the plan and field reviews, the greater the number of safety concerns that are identified, and vice versa. If the Team had early successes which gave the team confidence and enthusiasm. If the Team was given projects that were destined for failure, i.e., too late in the project development or already over budget, or if their concerns were not taken seriously, it is felt that future audits might have been less thorough.

A single audit required from one day to two weeks to complete and varied on the complexity of the project, thoroughness of the Audit Team's understanding of the project, and level of detail in reporting concerns. Most audits were performed in two days; however, the Coordinator had to acquire additional information to help with final determinations that prolonged the audit process in two audits.

COSTS: Most of the improvements incorporated into projects resulting from Road Safety Audit Reviews involved extra work and resulted in additional costs. Additional costs were never an issue in rejecting an improvement. The costs associated with safety concerns were generally accepted. Cost was a reason for not incorporating an

improvement only when the recommendations cited were well beyond the scope of the project. (DELAY seems to be more of a constraint.)

Initial audits are more time consuming and, therefore, slightly more costly due to the time needed to become familiar with the project. Subsequent audits were somewhat lower in cost to conduct. The cost of audits were somewhat higher when initial reviews were made during a later phase due to the amount of time needed to gain support for a change at the later date.

Not all projects necessitated the same level of effort to conduct the audit. Given rough estimates that were made and based on a simple \$50/hour analysis, an audit adds between \$2,000 and \$3,000 per review per project in salary and equipment. These costs are comparable with estimates produced in the United Kingdom, Canada, and Australia. Audits conducted by an external Team, such as a consultant or another agency, were not used.

DELAY: The Pilot was well accepted by most involved. Most knew delays may occur and was part of buying into this "safety improvement" Audit Process. Concerns cited later in the project development phases delayed the design; however, no project missed a letting due to redesigns. These concerns usually resulted in incorporating the improvement that will cause the least delay. A Capital Improvement Project underwent major redesigns and was in jeopardy of missing a major commitment because of concerns that were raised. But because the concerns were valid safety concerns, the District underwent major efforts necessary to incorporate the changes. For most audits, delays occurred; however, projects were not unreasonably delayed because letting commitments over-rode decisions to incorporate improvements that would greatly delay the project. Because these concerns did not result in improvements does not suggest that the audit process failed. The Coordinator can utilize the knowledge to have an improvement introduced through another project at another time and the lesson learned can be utilized in another project.

Delaying projects was found to be the most sensitive issue in the Road Safety Audit Process. It is even more sensitive than money because money can be moved or items can be eliminated. Time cannot be changed and commitments reflect on an agency's credibility and are extremely important to uphold.

DOCUMENTATION: Field reviews were extremely valuable and key in citing concerns. Many things were said and discussed during field reviews. Typical brainstorming techniques were not easy to perform in a van during a moving field view. Also, many conflicts occurred that did not get resolved during the field view. Documenting everything was extremely difficult. Do you bring a secretary? Do you take the time to write all brainstorming concerns down before you move on? We chose to videotape the entire field review, including brainstorming issues. This was found to be valuable; however, it requires much of the Coordinator's time to decipher notes afterwards.

Documentation can range from too little to too much. Some Agencies utilizing the Road Safety Audit Process have produced Audit Reports that are extremely comprehensive and voluminous. An agency needs to determine the optimum level that

captures all concerns, conveys needed improvements, communicates results, but does not restrict flexibility, increase tort exposure, and create unnecessary paperwork. The pilot varied the methods of reporting results to the Project Manager. Having no formal report reduced the concern of tort liability, but it caused a lack of communication and incorporation of results in many instances. Experience with the process will determine the optimum level. The Pilot incorporated many improvements with minor documentation because the Audits were performed internally and communication was open and continual. Most reports consisted of a one or two page letter from the Coordinator to the Assistant District Engineer for Design (second only to the District Engineer in authority) and cited concerns (with limited recommendations) with the checklists available for background data.

Citing specific recommendations was found to be undesirable because it left the Project Manager with no flexibility. It may also create unnecessary tort liability on the projects where a recommendation was not accepted for even very logical reasons. A formal report citing concerns, and not recommendations, followed by a meeting with the Project Manager to resolve concerns, discuss details not included, and select remedial treatments was found to be the most welcomed method by all involved. The report needed to be timely so the short windows of opportunity were not missed and information not forgotten.

Team members were always concerned with their comments creating the potential for tort liability by documenting concerns that may not be remedied. This initially stifled ideas during field reviews; however, the concern was limited by showing that the reports can be carefully prepared and worded to minimize tort exposure and convey potential needs.

Project Managers constantly needed reminded that a formal report back to the Coordinator is required for closure. There was no optimum time to draft this response and be assured that addenda will not be needed and tort liability will not be increased. Solving the concerns is a dynamic process that does not occur synchronously for the various concerns in the audit report.

An audit team from outside of the agency was not used. The reports from an external audit team, that may have limited regard of the agency's tort liability, could potentially be damaging and serve to be counterproductive if the agency's entire program management is not considered. This is not to imply that concerns should go unstated when faced with difficult decisions, but that the preparation and wording of a report can make a big difference in the added value of an audit.

SUITABLE PROJECTS: Not all projects were efficiently and effectively audited. Capital improvement projects were excellent candidates for Road Safety Audits. They resulted in the most number of successful improvements because they generally had more time available in which to redesign, already involved right-of-way acquisitions, and had the greatest level of funding available to absorb cost increases. New construction projects generally have less constraints and more funding which is often a rare opportunity to make extraordinary improvements that may provide a safe and efficient roadway for years to come. PennDOT utilizes many processes throughout normal project

development that are intended to identify the vast number and variety of stakeholders' needs. Normal project development for larger projects may include public hearings and additional internal reviews that provide similar beneficial input that could lessen the need for, or the value added, by an audit. For example, the District is presently designing some projects with the assistance of a Community Advisory Committee that is made up of many local stakeholders that provide continual input on the needs of the community and assist in project development. Although concerns were still found, efforts may have been better utilized on another project.

Rehabilitation projects are also good candidates. They generally provided opportunities because the initial scope of work is already broad, already includes right-of way acquisition, and can incorporate improvements with only minor changes. They have a higher level of funding that can absorb cost increases. Because much of PennDOT's available funds are used to provide winter services, diligent planning was required to provide these types of projects on the major arterial roadways on a ten year cycle. If you do not include needed safety improvements at the time of the project, another opportunity may be ten years away.

Road Safety Audits on projects utilizing Federal Hazard Elimination Funds did not result in many concerns because they generally included a much smaller section of roadway and an existing emphasis on safety.

Bridge reconstruction projects benefited from audits. However, only the projects involving a complete rehabilitation were found to have successfully incorporated improvements because most are providing an effort to improve the alignment and roadway approaches. Other than bringing some features up to current standards, projects involving only deck replacements have a very narrow scope and do not relate to features scrutinized by an audit.

Surface improvement projects can be notorious for painting the road black and not looking back. In other words, they are to improve ride quality and extend pavement life, and have little money available for additional improvements. They are usually funded by State monies, which tend to be stretched as far as possible. The Pilot found little support for major improvements. Ironically, this is probably where there were the most concerns, because speeds will be increased and most design features were not improved. Therefore, unless the agency will consider drastically increasing the scope of work, surface improvement projects are not good candidates for audits.

Permit projects usually have no lead-time, receive little cooperation from property owners, and involve funding outside of the agency, making them very difficult to successfully audit. Ironically, because little or no public money may be involved, the benefits and opportunities in an audit could be enormous. But, there will be resistance from the developer with redesigns and continual reviews.

SUITABLE PHASES OF PROJECT DEVELOPMENT: The Road Safety Audit Pilot audited projects in the various phases of project development and monitored the experiences and results to determine if success was dependent on the phase. It was immediately obvious that audits initially performed in a later phase were not necessarily

doomed for failure, but resulted in an incorporation of a fewer number improvements. The defining line appears to be the completion of the environmental approval. After this time, the amount of effort needed for major design changes is greatly increased and often resisted.

Successfulness of the audits depended on the type of project and the phase at which cited the concern. Early audits had a much higher probability in getting concerns corrected because there is a construction project that can immediately address the need. Most concerns cited in preliminary engineering phases were addressed. Concerns cited in the later phases of projects (beyond mid point of final design) were scrutinized more closely and required cost beneficial improvements to be incorporated. If there was more than one way to address a concern, the least expensive way was selected at this point.

During Construction, or the Pre-Opening Phase, the audit was very beneficial in determining if the changes that were made in the field to the design were acceptable. Mostly changes of this nature were due to constructability problems, which left no other choice, but to make the change. The Road Safety Audit Team knows that these changes are inevitable. But, another audit in this phase can determine if there was a corresponding safety concern and attempt to compensate for the change. If it was strictly a monetary decision, which are also inevitable, the audit still allows time for the agency to weigh the potential safety concerns against the costs associated with reconstructing now, or even worse, later after the contractor is gone.

Concerns initially raised after construction started were very difficult to sell because of the numerous ramifications that are involved in late changes. These audits were beneficial in identifying concerns relating to utility locations and roadside barrier designs. Any concern first raised while the contractor has begun work will most often be very costly due to being additional work; although, it will be less expensive than after the contractor is gone. Some field construction personnel did not buy into the Road Safety Audit Process due to other numerous demanding priorities during construction. In fact, one Project Engineer stated: "Sure! As soon as you guys leave, another van load will be here to see how I'm controlling my cost overruns!"

Once the contractor is gone, the cost to improve a roadway is increased drastically and the desire to make changes decreased drastically; therefore, in-service audits were not successful. The agencies performing Road Safety Audits consider In-Service and Existing Road Reviews as a completely separate process from Road Safety Audits. Mostly because it is usually futile to expect that a roadway built prior to 1960 can feasibly conform to the safety standards of today without the benefit of a rehabilitation project. However, often a review of an existing roadway can result in a list of locations that can be improved, systematically, in a low cost manner. The risk is that the list may be long and become a potential tort liability.

CONTROL: Research of the Road Safety Audit Process indicates that various agencies prefer to have Police and other outside representatives on the team. However, unfavorable decisions based on all existing constraints and information at the time often need to be made that could be damaging and/or counterproductive if improperly

exposed outside of the agency. Some non-agency personnel may have hidden agendas that may be counterproductive, also. This issue was not satisfactorily evaluated; however, many outside representatives were valuable to the Team when used as a resource person and used to answer questions and cite local knowledge.

The Road Safety Audit Process did not control the projects. Controversial improvements were not incorporated if delaying the letting was a possibility. This is not unacceptable even from a pure safety perspective when the overall program management is considered. The buy-in process of the audits maintained the perspective for the audit reports to be used as an additional tool for the District Engineer to help identify potential use of funding and not as “unfunded mandates.” Some improvements were desirable, but were not worth delaying or losing a badly needed project. The positive perspective is that this should not be an issue if the Road Safety Audit is performed early enough in project development. If it is not, those responsible for project management will need to make a difficult decision. Furthermore, if the improvement is not accepted, the Project Manager and the Road Safety Audit Team will have learned from the experience.

CONFLICT RESOLUTION: Conflicts were expected to arise at three time frames in the Road Safety Audit Process and were monitored to provide information to determine if the process is feasible and how to best reach consensus. Conflict resolution in citing concerns, reporting concerns, and accepting remedial improvements can allow the process to succeed or fail. The pilot had a set and accepted procedure prior to beginning. The ground rules included: 1.) The team must reach consensus on citing concerns, 2.) The Team must avoid hidden agendas, and 3.) The Team must accept the decisions of the Project Manager.

Only minor conflicts arose within the team in citing concerns and consensus was, most often, easily reached. It appears that the ground rules contributed to gaining and maintaining the necessary buy-in of the Road Safety Audit Process Pilot. When the Team consisted of more than five members, consensus was often not obtained and some concerns were not formally cited. Consensus could not be reached on a major issue in a project creating a lengthy delay in the audit process so support information could be obtained and challenged the proper method to document the concern. It also challenged some support staffs’ buy-in to the Road Safety Audit Process when their recommendations were not endorsed by the Team. Ultimately, however, having the issue raised and discussed in detail appeased the staff.

Secondly, when recommendations were reported, many conflicts arose because the Project Managers could not always incorporate all improvements exactly as requested due to various reasons. When only concerns were cited and a follow-up meeting was held to resolve the concerns in the best manner feasible, conflicts were avoided. This was the most effective procedure, particularly in the later phases when time and money were most critical, because it provided flexibility in the improvement that is incorporated.

Lastly, when incorporating improvements into the project, conflicts involving money and time were the most common. Improvements that could negatively impact project development by bankrupting or seriously delaying the project were very difficult to sell to

the Project Managers. The District has a Program Management Committee at the Administrative Staff level that was ready to make final determination relative to cost and delay, when necessary. Most often, conflicts were resolved through finding ways to collectively resolve the concern in a manner acceptable to the Coordinator and the Project Managers. An external audit team may make this a bit more challenging because of their increased resistance toward the constraints.

The most difficult conflicts to resolve were those that arose from audits during the pre-opening phase. The construction Project Managers also need to buy-in to the Road Safety Audit Process and are very important to its success because their field changes may unknowingly create safety concerns. Also, during construction, time is of the essence, which makes improvements requiring changes difficult to sell and incorporate. Construction Project Managers have many conflicts to resolve in order to complete projects on time and within budget at this stage, any changes must be unanimously agreed upon and cost effective.

LIABILITY: Identifying concerns that may not get adequately addressed, even for good reasons, may be damaging in future torts. Even concerns adequately addressed could be damaging in torts from crashes that occurred years ago by providing ammunition for a plaintive that a concern may have existed. Having a process that is focused to address safety concerns of all varieties has to reduce tort exposure. The Countries that have been utilizing the Road Safety Audit Process strongly believe that everything should be well documented; however, these Countries have agencies that are protected in courts. PennDOT is covered by Statute that deems safety studies as “non-discoverable.” However, this has not caused the Audit Team to take a shotgun approach and cite irrelevant concerns just to cite concerns. The Audit Team was prudent and responsible when raising concerns. Concerns and/or recommendations must enhance safety, but they should also be feasible. (The extreme example would be for the Audit Team to not recommend a by-pass when the scope of work of the project is to solely resurface a roadway.) An irresponsible report will only serve to potentially cost the agency much-needed dollars. Reports need to be clearly thought out to prevent restricting flexibility for the Project Manager. Agencies cannot, and will not, manage their projects by fear of tort liability.

RECOMMENDATIONS

The following is a compilation of recommendations for adaptation of the Road Safety Audit Process that are based on PennDOT District 10's experiences:

- Achieve Management Commitment ("Buy-In") at all levels prior to beginning. The Road Safety Audit Process can distract an agency from their normal project development routine by adding additional reviews which usually results in changes, additions, and/or deletions of portions of the design. This can cause delays, cost overruns, and conflicts if those involved do not understand, accept, and prepare for the possibility for change. Having buy-in at all level of project development, i.e., District Engineer, Plans Engineering, Program Engineering, Designers, Road Safety Audit Team, Safety Review, and all other involved internal and external Units, helps to allow the Process to be effective.
- Utilize a Coordinator to keep the process moving and allow it to be effective for a number of projects by coordinating reviews, preparing accurate comments, interacting with many Project Managers, selling safety concerns, determining adequate solutions, and resolving conflicts. To effectively do all of these requires a person(s) that has knowledge, experience, and enthusiasm. To effectively do all of these requires a person that has knowledge, experience, and enthusiasm. Because timing is often critical to success, the Coordinator's role must be very active so communication is maintained with the Project Managers throughout the development of the projects.
- The Coordinator and Project Manager should work closely but separately. The Coordinator must be kept current on all projects undergoing audits through periodic and open communication. Accurately advising each other (Design/Road Safety Audit) of the status and events of projects in a timely fashion can prevent "wheel spinning" from unnecessarily occurring. For example, a project that was in the Pilot's Audit Process had a major down-scoping, i.e., from a Betterment Project (major reconstruction) type to a Surface Improvement Project (1 1/2 " of bituminous concrete, ONLY) without the knowledge of the Coordinator, which resulted in a futile field review. The Coordinator also needs to be kept current on the status of previously cited concerns.
- Although, it is very important that they remain separate, so they remain excluded from normal biases and constraints.
- Select an interdisciplinary team with experience. Interdisciplinary knowledge ensures that safety concerns are considered from all facets of highway engineering. Experience ensures a high quality review. Also, Team members must be adept at visualizing planned features since plans often do not exist during audits.
- Limit non-agency team members. Non-agency members may provide valuable information; however, there is a great risk of losing control of the project by potentially allowing unfavorable information to get outside of the agency. Decisions were made and information revealed during the audits that could have been misconstrued and potentially damaging if not all of the facts surrounding the circumstances were known and/or understood. Therefore, it may be better to search for the information offered by

others through other formats. Non-agency Team Members may not be a concern once the process becomes more widely accepted so non-successes are better accepted. Use can also be dependent on the agency's ability to keep control of a project during the threat of public adversity.

- ❑ Provide training to team members in Human Factors, AASHTO Greenbook and Roadside Design Guide, Manual of Uniform Traffic Control Devices, Accident Reconstruction, Intelligent Transportation Systems, and Access Management. An agency may not have all of the recommended expertise; therefore, training may be a need. Training may also keep an agency from having to acquire an expert from outside. As Team members change, so will the needs to provide training. This is extremely important so the Team is as productive as possible. In time, expertise will build.
- ❑ Major reconstruction projects should include additional expertise, such as FHWA, other Agencies, other Districts/Bureaus, etc. New construction projects generally have less constraints and more funding which is often a rare opportunity to make extraordinary improvements that may provide a safe and efficient roadway for years to come. Expertise from outside the District can provide input of features and items that have and have not functioned safely in other areas and regions.
- ❑ When beginning the Audit, the Coordinator must be prepared so the team remains informed, aggressive, cooperative, and enthusiastic. The Project Manager should be at the initial review to provide the background information, especially in the early phases when plans may not yet be available. However, he/she should remain removed from discussions. Video taping the entire field review can ensure that all comments are captured and can allow the note-taker to actively participate in brainstorming. This requires work after the field reviews to decipher tape/notes, but ensures accuracy and is convenient when the team needs to revisit an issue.
- ❑ Local residents and others outside the agency should be solicited to help determine the needs of all road users and stakeholders.
- ❑ Be selective in the projects that will be audited and the number of audits performed throughout the projects' development. Development of a project may routinely include considerations in an Audit and, therefore, effort may be better spent toward another project. Also, some projects may not greatly benefit from multiple Audits throughout project development. Cost effectiveness must be balanced with the existing efforts, the risk, and the complexity of the design. Experience with the Road Safety Audit Process will help in selecting suitable projects and project phases more conducive to the audit process with less repetition of that in the agency's routine project development.
- ❑ Select projects that have the capability and flexibility to change. Do not set the Team up for failure! **And START EARLY so you can change!**
- ❑ The Road Safety Audit should be a totally separate process from the normal and routine safety review. Both processes have their specific purpose and need. District 10 did not even have the safety review committee chairman on the Road Safety Audit Pilot Team to determine if a successful safety audit could be conducted without the biases

that the chairman may bring from working with the design team previously. The Road Safety Audit Process is to be independent. In addition, knowledge of crash data is irrelevant to the audit--the team is looking for crash potential. Hopefully, and very importantly, crash history is addressed by the safety engineer working cooperatively with the design team.

- ❑ Attempt to provide your agency with confidentiality. Although Pennsylvania is no longer protected by Sovereign Immunity, it is protected by a Statute that deems “safety studies” as “non-admissible” in Torts and may keep from having to release audit reports. This is a security blanket; however, it may not be practical nor an option for some Agencies. The concern of Liability is valid, but the benefits that can be realized will outweigh the risks if care is taken when documenting the results of the audit.
- ❑ A formal report identifying the issues raised in the audit should be prepared. The report should be prepared with care and provide the formal documentation on which decisions about corrective action will be based.
- ❑ **Cite concerns not recommendations.** This is one of the most important issues learned in the Pilot. Recommendations and solutions may be too restrictive for the Design Team and could be the biggest cause for tort liability concerns if the recommendation cannot be incorporated. Reports must be carefully thought out and worded in such a way so “smoking guns” are not created by citing specific concerns that are not incorporated that may be construed as the agency being negligent in a future tort even if there is very good reasoning for not incorporating. Not wanting to create a potential liability concern was a major focus for all Team Members. Some concerns were stifled because of this. Therefore, by carefully preparing and wording the reports, Team Members will see that they are not creating a tort liability and their ideas will not be stifled.
- ❑ A follow-up meeting with the Project Manager should be held to clarify results, sell the concerns, discuss possible solutions, and discuss needed actions. This also allows an opportunity to advise the Project Manager of details that the Team may have not included in the formal report.
- ❑ The report needs to be timely so the short windows of opportunity are not missed and information is not forgotten.
- ❑ Set an acceptable protocol for resolving conflicts within the Team and with the Project Manager. The normally accepted approach is that all members of the Team must agree with a cited concern. Buy-in and an understanding of the Road Safety Audit Process helped make conflict resolution among Team Members a minor issue. To be successful, The Road Safety Audit Team, the Design Teams, the Programming Engineers, and everyone involved in the project development process must understand the Audit Process and know what to do when a conflict occurs. Having a set and accepted procedure prior to implementing the Pilot showed all parties that not everything would be completely satisfactory to everyone. The team must reach consensus and the Coordinator must avoid hidden agendas so concerns cannot be labeled as self-serving; the Project Manager and the Coordinator must mutually resolve

the conflict; the district's Program Management Committee will make final determinations relative to cost and delay; and the team must accept final decisions. Not all concerns will be well accepted. It helps if everyone knows what to do if issues cannot be settled. An agency cannot afford to procrastinate because they do not know how to resolve an issue. More importantly, an agency does not want to just drop an issue because it could not decide what to do. This concern is minimized with buy-in.

□ Consider using technology to gather data, to record documentation, and to solve concerns. Try to ease the burdensome facets of the Road Safety Audit Process, like note taking, measurements, report writing, etc. to allow the Process to be less cumbersome and even fun. Videotaping was extremely helpful for the Coordinator in capturing all discussion. It was also used to revisit certain locations. Laser Measuring devices can quickly and easily measure speeds, grades, and distances that could determine, at a touch of a button, if there is a specific concern pertaining to roadway or operation of the roadway. A laptop computer can speed up note taking and especially report writing. It is important that the Team remains knowledgeable of the state-of-the-art technology that can be easily incorporated into projects to enhance safety. Examples include Intelligent Transportation System devices (Dynamic message boards for information and closed loop signal systems for congestion) and Signal Advancements (emergency vehicle preemption for EMS vehicles and queue detectors for congestion).

FUTURE PLANS

PennDOT's Road Safety Audit Process Pilot Project is complete. However, the Pilot is now under close evaluation and PennDOT will soon incorporate the process in some form throughout Pennsylvania. The checklists will immediately be given to all Project Managers in every Engineering District and a Road Safety Audit Team, or Teams, will be formed to conduct a limited number of audits. Each Engineering District will utilize their strengths to capture the key elements of the Road Safety Audit Process to the best of their ability given the limited available resources.

District 10 will be trying new methods and practices to become more familiar and proficient with the process and to determine methods that can further integrate safety into roadway construction projects. District 10 hopes to incorporate an audit from a team of experts outside of the district, but within PennDOT, to determine if a totally unfamiliar view would be beneficial or preferred. Police officers will also be used as resources to determine if their knowledge of the roadways' operational experience is helpful in conducting Audits. Additionally, portions of the FHWA's Older Driver Handbook will be incorporated into the checklists, nighttime reviews will be considered, and methods to determine the best feasible methods in obtaining the needs of all road users will be sought.

SUMMARY

Although PennDOT's normal project development inherently incorporates safety into designs through various procedures, the Road Safety Audit Pilot created awareness and appreciation for the Road Safety Audit Process as a useful tool to maximize the safety potential of roadway construction projects through prudent use of the following:

- ◆ Interdisciplinary experience to brainstorm possible problems,
- ◆ Human factors and multi-modal considerations to ensure a safe roadway for all road users,
- ◆ Checklists to surface safety concerns,
- ◆ Field reviews to maximize opportunities and minimize missed opportunities to improve safety,
- ◆ Learning from the experiences, both successes and non-successes

Does the Road Safety Audit Process add value?

It should be no surprise that any detailed review, especially one focused purely on safety, will most likely identify safety concerns, which if corrected, will add value. The Road Safety Audit Team found potential problems associated with several types of projects in various stages of development. Efforts were made to not have the audit be influenced by the activities of the safety review committee in their performance of safety reviews. The Safety Review Committee primarily addresses adherence to standards. The Road Safety Audit Team performed a different function, one that can identify issues that would not have been discovered as part of the Safety Review whereby adding safety value. It can ensure a quality product by preventing occurrences that may adversely affect safety and be costly to repair. It can also maximize opportunities to enhance safety and minimize missed opportunities to enhance safety.

With this added value, however, there is some additional risk involved as well. Does using the Road Safety Audit take the control of the project out of the hands of the Project Manager and put it into the hands of the Audit Team? Are there time problems associated with scheduling another set of meetings? What are the implications if certain concerns raised by the Audit Team are not addressed? These obstacles must be addressed through buy-in, the strengths of the individual agency, and awareness.

Can the Road Safety Audit Process be implemented within existing resources?

It is estimated that the average cost of an Audit in the pilot process is \$2,000 to \$5,000. This cost is based on an internal review Team and includes only salary and equipment costs. This cost is comparable with estimates produced in the United Kingdom and Australia and is very little for the amount of success achieved. Audits conducted by an external Team, such as a consultant or another agency, were not used. Not all projects required the same level of effort to conduct the audit and not all projects were good candidates for audits. Improvements have added costs to the project development; however, this is not considered as a cost of the audit. This is a factor that must be considered on a project-by-project basis.

Will the Road Safety Audit process delay project delivery?

The Road Safety Audit Process can delay the overall project development. The amount of delay is dependent on the type of project and the stage of the audit. For simple designs that are audited early in the development of the design, the delays are

minimal. For complicated projects audited after the environmental approval is approved or in later stages, the delays could be long and may jeopardize the letting of the project. An agency must balance the benefits derived from the audits with project commitments on an individual basis. If an agency would determine that the audit would control project development, there will be delays in delivery. However, it is most probable and prudent when considering all factors, that the agency will use the audit as a tool, act responsibly on a project-by-project basis, but will not considerably delay a project.

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Last Updated on 1/19/99